



## Solving solubility—predicting precipitation reactions

A solubility table summarises the solubility in water of many common ionic compounds.

| Soluble ionic compounds                            |  |
|--|--|
| Most compounds of the following ions are soluble   | Important exceptions   |
| Nitrates ( $\text{NO}_3^-$ )                       | None   |
| Acetates ( $\text{CH}_3\text{COO}^-$ )             | None   |
| Sodium, potassium ( $\text{Na}^+$ , $\text{K}^+$ ) | None   |
| Ammonium ( $\text{NH}_4^+$ )                       | None   |
| Chlorides ( $\text{Cl}^-$ )                        | $\text{AgCl}$ , $\text{HgCl}_2$ , $\text{PbCl}_2$ —slightly soluble                              |
| Bromides ( $\text{Br}^-$ )                         | $\text{AgBr}$ , $\text{HgBr}_2$ , $\text{PbBr}_2$  |
| Iodides ( $\text{I}^-$ )                           | $\text{AgI}$ , $\text{HgI}_2$ , $\text{PbI}_2$   |
| Sulfates ( $\text{SO}_4^{2-}$ )                    | $\text{BaSO}_4$ , $\text{PbSO}_4$ , $\text{CaSO}_4$ —slightly soluble                            |
| Insoluble ionic compounds                          |  |
| Most compounds of the following ions are insoluble | Important exceptions   |
| Sulfides ( $\text{S}^{2-}$ )                       | $\text{Na}_2\text{S}$ , $\text{K}_2\text{S}$ , $\text{Li}_2\text{S}$ , $(\text{NH}_4)_2\text{S}$ |
| Carbonates ( $\text{CO}_3^{2-}$ )                  | $\text{Na}_2\text{CO}_3$ , $\text{K}_2\text{CO}_3$ , $\text{Li}_2\text{CO}_3$                    |
| Phosphates ( $\text{PO}_4^{3-}$ )                  | $\text{Na}_3\text{PO}_4$ , $\text{K}_3\text{PO}_4$ , $\text{Li}_3\text{PO}_4$                    |

- 1 The following solutions are mixed together. Indicate whether or not you think a precipitate will form by placing a tick or cross in each box in the second column. For each predicted precipitate, write a full balanced chemical equation in the third column.

| Solutions mixed                       | Precipitate?<br>(✓ or ✗) | Balanced chemical equation |
|---------------------------------------|--------------------------|----------------------------|
| potassium chloride + silver nitrate   |                          |                            |
| copper(II) nitrate + sodium hydroxide |                          |                            |
| magnesium nitrate + sodium chloride   |                          |                            |
| lead nitrate + potassium chloride     |                          |                            |
| sodium sulfate + calcium nitrate      |                          |                            |

- 2 Outline an experimental method a student could follow to obtain a dry sample of calcium carbonate from solutions of calcium chloride and sodium carbonate.

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# Recording reactions—full and ionic chemical equations

1 Choose from the terms below to complete the summary statements outlining the key points about full chemical and ionic equations.

|           |           |            |         |          |               |
|-----------|-----------|------------|---------|----------|---------------|
| conserved | solid     | aqueous    | gaseous | atoms    | rearrangement |
| soluble   | liquid    | dissociate | ionic   | created  | reactant      |
| destroyed | spectator | product    | change  | balanced | dissolved     |

- a Chemical equations are a way of representing the \_\_\_\_\_ of atoms in a chemical reaction.
- b Mass is always \_\_\_\_\_ in a chemical reaction. Atoms are neither \_\_\_\_\_ nor \_\_\_\_\_.
- c The number and types of atoms present before a chemical reaction are also present afterwards. Hence a chemical reaction must be \_\_\_\_\_ for each type of atom.
- d The state of each \_\_\_\_\_ and \_\_\_\_\_ is indicated by the following:
- (s) indicates the substance is present in \_\_\_\_\_ form
  - (aq) indicates the substance is \_\_\_\_\_, i.e. \_\_\_\_\_ in water
  - (l) indicates the substance is present in \_\_\_\_\_ form
  - (g) indicates the substance is present in \_\_\_\_\_ form
- e A \_\_\_\_\_ chemical equation includes all of the \_\_\_\_\_ present when a chemical reaction takes place. It does not always describe the chemical \_\_\_\_\_ accurately because not all atoms present are always involved in chemical change. \_\_\_\_\_ ionic compounds \_\_\_\_\_ into their ions in solution. The ions that remain unchanged over the course of the reaction are termed \_\_\_\_\_ ions.
- f An \_\_\_\_\_ chemical equation omits spectator ions. It focuses on the actual reaction taking place.
- 2 Acids show similar chemical behaviour. They react with many metals and metal compounds in common ways. Complete the following table by predicting the products of each reaction and writing balanced full and ionic chemical equations.

| Reactants                                       | Products | Equations       |
|---|----------|-----------------|
| Sulfuric acid and zinc metal                    |          | Full:<br>Ionic: |
| Nitric acid and aqueous potassium hydroxide     |          | Full:<br>Ionic: |
| Hydrochloric acid and sodium carbonate solution |          | Full:<br>Ionic: |
| Hydrochloric acid and solid magnesium oxide     |          | Full:<br>Ionic: |
| Sulfuric acid and solid copper sulfide          |          | Full:<br>Ionic: |

# Concentration and strength—picturing acids and bases

Complete the following table. The first row has been completed for you.

| Solution                       | Weak or strong acid or base? | Particles present in solution   | Sketch showing relative proportions of particles |
|--------------------------------|------------------------------|---|--|
| Concentrated hydrochloric acid | Strong acid                  | H <sub>2</sub> O molecules<br>H <sup>+</sup> ions<br>H <sub>3</sub> O <sup>+</sup> ions | <br>Concentrated HCl(aq)                         |

|                            |  |  |  |
|----------------------------|--|--|--|
| Dilute nitric acid         |  |  |  |
| Concentrated ethanoic acid |  |  |  |
| Pure sodium hydroxide      |  |  |  |
| Dilute sodium hydroxide    |  |  |  |